Levels of Polychlorinated Biphenyls in Adipose Tissue of the General Population of the Nation

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Polychlorinated biphenyls (PCBs) have been reported in many different parts of the environment in this country (1–3). The purpose of this report is to present preliminary results from a monitoring program in which these materials are routinely sought and quantitated.

The Human Monitoring Survey, established in 1967 by the Pesticides Program, DHEW (now Division of Pesticide Community Studies, EPA), determines, on a continuing basis, the exposure to pesticides experienced by the general population by measuring levels of pesticide residues present in tissues or excreted in urine. Initially, technological limitations and resource restrictions limited the Survey to the identification and measurement of those chlorinated hydrocarbon residues which are stored in measurable amounts in mammalian adipose tissue, or which can be measured in blood, these residues being a reflection of past exposure. The initial program plan has been and continues to be reviewed frequently with reference to technological and/or research developments to identify other groups of pesticides and other materials of interest, which can be incorporated with slight modification of the existing program.

Samples are collected through the direct cooperation of pathologists, who are in hospital or private practice or who are in public service as city or county medical examiners. Samples are collected from both sexes in all age and racial groups. Adipose samples are collected from tissues removed for therapeutic surgery or from postmortem examinations, the latter including people who have died accidentally (trauma) or during relatively brief hospitalization. No samples are accepted from institutions for long-term care of the chronically ill patient.

All samples are analyzed by laboratories established under contract with State Health Departments or at community study projects in Michigan, Florida and Colorado. These laboratories use analytical methodologies specified by the program on the advice of technical consultants and are required to maintain acceptable levels of performance, as demonstrated in both inter- and intra-laboratory quality control programs. Technical consultation for analytical aspects of the Survey is provided by the Chemistry Branch, Perrine Primate Laboratory, EPA, under the direction of Henry F. Enos, Ph.D., Chief.

In 1969, with the increased interest in polychlorinated biphenyls, it was recognized that PCBs probably occur in several segments of the environment and that their presence would distort analytical values for certain pesticides, especially selected DDT residues. The monitoring laboratories were therefore asked to report all samples suspected of containing PCBs by gas-liquid chromatography. A reporting system was developed based on rough quantitation, as follows: negative, present in usual amounts, present in greater or lesser amounts than usual. Samples collected in late 1968 and 1969 showed that PCBs were indeed present in a significant portion

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of the general population of the country over a wide geographic distribution. Positive samples were reported from 14 States, including Michigan, New York, Minnesota, California, Massachusetts, Georgia, Kentucky, Illinois, North Carolina, South Dakota, Ohio, Louisiana, Delaware and Arkansas. To insure that proper identification was being made, two samples with higher levels were confirmed by combined gas liquid chromatography-mass spectroscopy (4). These two cases are discussed in another paper in this symposium (5).

Based on these preliminary findings and certain as yet unpublished information about the effect of PCBs on the accuracy of measurement of residues of DDT (Enos, H. F., personal communication), high priority was given by the Perrine Laboratory to the development and evaluation of an analytical method which would separate PCBs from pesticides permitting accurate quantitation of pesticides and confirmation of PCB levels. The resulting methodology is a further modification of the Mills-Olney-Gaither procedure in which adipose tissue is subjected to extraction by petroleum ether, acetonitrile partitioning, and Florisil cleanup. A portion of the resulting 6% ethyl ether/petroleum ether eluate, in concentrate form, is treated with KOH to effectuate dehydrochlorination of DDT and DDD to their olefins, thus eliminating the problem of separating these pesticides from the PCBs. Oxidative treatment is then applied to convert any interfering DDE to p,p′-dichlorobenzophenone which has an Rf value different from the PCBs. The PCBs are then determined by thin layer chromatography (6).

On April 15, 1971, all monitoring laboratories in the Human Monitoring Survey adopted this methodology for the analysis of all adipose samples with the lowest limit of sensitivity being 1.0 ppm. Aliquots of all samples in which measurable amounts of PCBs are found are saved for future confirmation by mass spectroscopy.

Table 1. Incidence of polychlorinated biphenyls in adipose of the general population of the nation.

	Reported		Analyzed	
	No.	%	No.	%
Total	637	100.0	688	100.0
Negative	314	49.3	235	34.2
Trace–<1.0 ppm	125	19.6	229	33.3
1–2 ppm	165	25.9	188	27.3
>2 ppm	33	5.2	36	5.2

Table 2. Descriptive statistics of samples analyzed.

	Negative and trace–<1.0 ppm		>1.0 ppm	
	No.	%	No.	%
Total number	439	100.0	198	100.0
Sex				
Male	221	50.3	127	64.1
Female	218	49.7	71	35.9
Race				
White	381	86.8	151	76.3
Nonwhite	58	13.2	47	23.7
Samples from				
Therapeutic surgery	95	21.6	29	14.6
Postmortem	344	78.4	169	85.4
Diagnostic group				
Neoplasms 140–209	77	17.5	39	19.7
Circulatory system 390–450	121	27.6	61	30.8
Gastrointestinal system 530–565	44	10.0	16	8.1
Liver & gall bladder 570–575	20	4.6	6	3.0
Pancreas 577	0	0.0	2	1.0
Urinary system 580–595	11	2.5	7	3.5
Congenital Anomalies 740–759	5	1.1	1	0.5
Accidents & violence E numbers	16	3.6	7	3.5
All other	145	33.0	59	29.8
	439	99.9	198	99.9

Results and Discussion

Analytical results for 637 samples have been reported and are summarized in Table 1 (51 additional samples have been analyzed but have not as yet been reported). Of the 637 samples reported, 198 (31.1%) contained measurable amounts of PCBs and 125 (19.6%) contained trace amounts, with the balance being negative. These samples were collected from 40 pathologists in 38 cities distributed over 18 States and the District of Columbia. The States are Arkansas, Illinois, Louisiana, Oklahoma, South Dakota,

Tennessee, Oregon, Pennsylvania, Florida, Kansas, Maine, Georgia, North Carolina, California, Michigan, New York, Ohio and Kentucky. Positive samples came from every hospital, city and state sampled. It, therefore, appears that these materials are widely found in the population. Details of distribution by sex and race, collection procedure, and diagnostic groups are summarized in Table 2. The difference between figures for the positive and negative groups does not appear to be significant, although no statistical evaluation has been attempted because of the preliminary nature of this report. Since a statistical design has been established and is being followed for sample collection for the Human Monitoring Survey, in due time valid statistical analysis will be possible and will then be performed.

Summary

Polychlorinated biphenyls have been found in measurable amounts in 31.1% of 637 samples of human adipose tissue collected from the general population as a part of the Human Monitoring Survey. Sample collection involved 18 States and the District of Columbia. Positive samples were obtained from every State sampled.

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